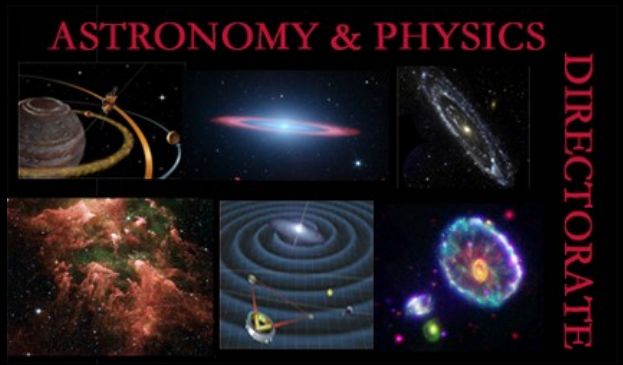
Jet Propulsion Laboratory
California Institute of Technology

Overview: Astronomy and Physics Directorate

Leslie Livesay
Dan Coulter

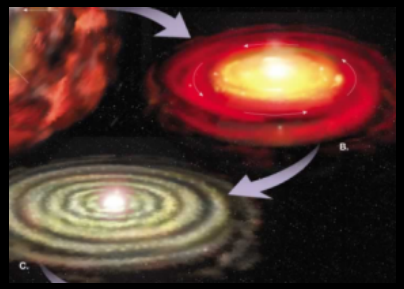


October 5, 2018

Science Focus (1 of 2)

Exoplanetary Systems

- How do planetary systems form and evolve?
- How can we recognize life on planets outside the Solar System?
- Is there life elsewhere in the Universe?

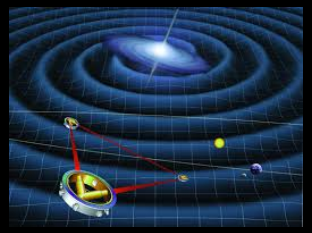


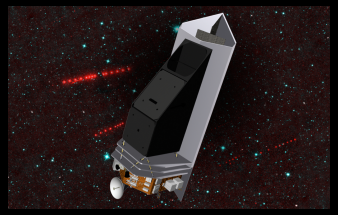
Long wavelength (l>visible) Astronomy & Cosmology

- How did the Universe form and evolve?
- What are the characteristics of dark matter and dark energy?
- How is matter of all kinds distributed throughout the Universe?
- What can the polarization of the cosmic microwave background reveal about the physics of inflation?
- How do stars form?
- How did galaxies and clusters of galaxies form and evolve?

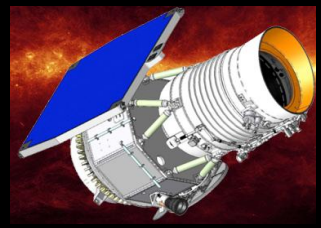
Science Focus (2 of 2)

- Gravitational Waves
  - Use gravitational waves to study matter and energy in extreme environments that have never before been observable. Opening a “new window” on the universe and asking what do we see?

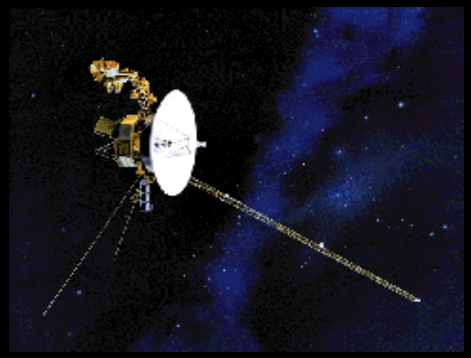




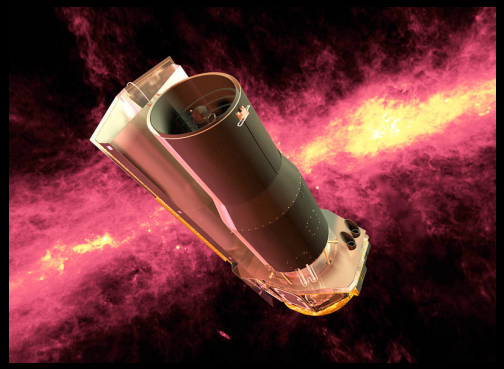
- Near Earth Objects
  - Planetary Warning/Defense
    - What objects in the Solar System could hit the Earth with destructive energy?



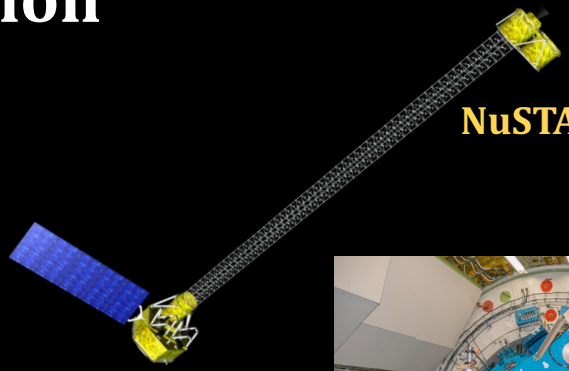
Current Missions and Instruments in Operation



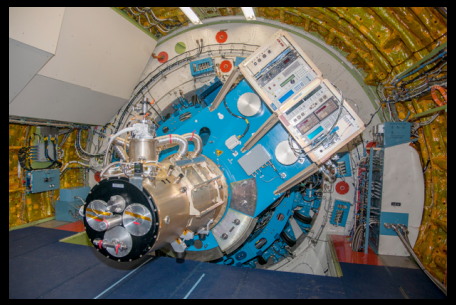
Two Voyagers 1977



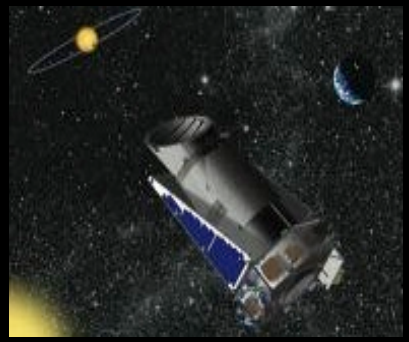
Spitzer 2003



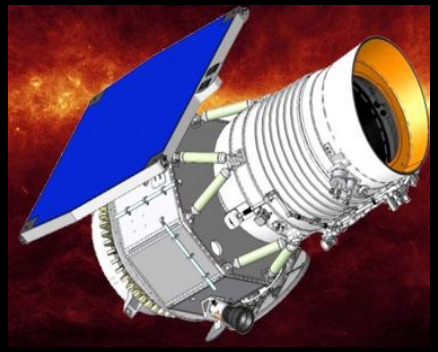
NuSTAR 2012



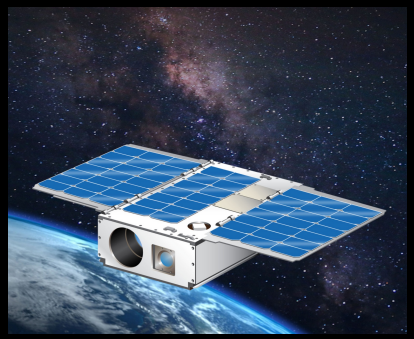
HAWC+ on SOFIA 2016



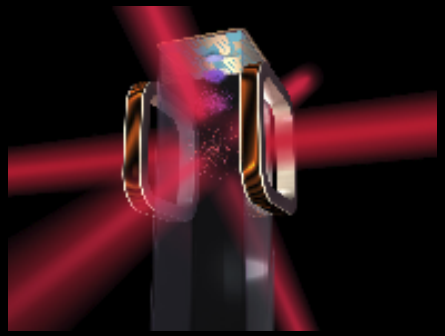
Kepler/K2 2009



Wise 2009
(Restarted for NEOWISE 2013)



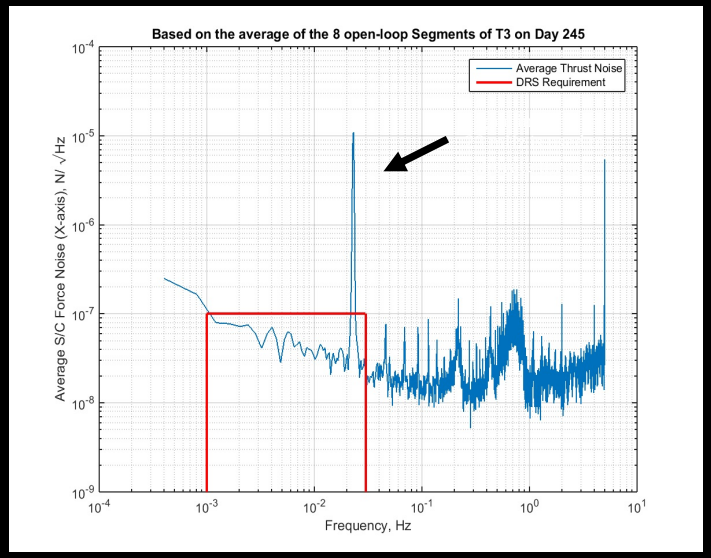
ASTERIA Cubesat 2017



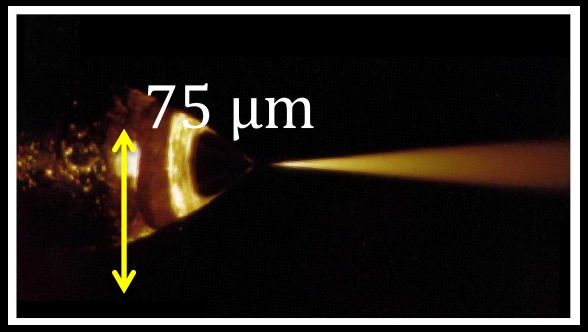
CAL 2018

ST-7/LISA Pathfinder Mission Success

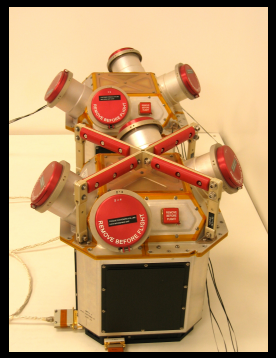
- ST-7 demonstrated drag-free spacecraft attitude and position control with precision and low-noise electrospray thrusters and control algorithms for a gravitational wave observatory.
- ST-7/DRS met all L1 mission requirements.
- At maximum thrust, ST7 can offset the mass equivalent to a mosquito sitting atop the spacecraft in increments of 100 nN.



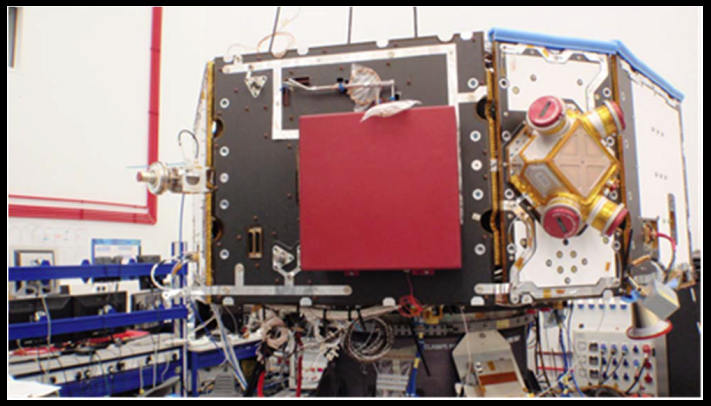
Amplitude spectral density of average thrust noise on the spacecraft with requirement in red.



Colloid Electrospray Thruster (Busek Co, Inc)



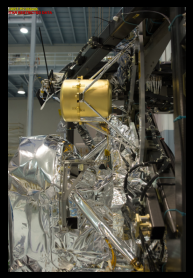
Cluster of four Colloidal thrusters during testing at JPL



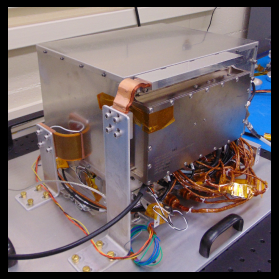
One of two Clusters mounted on the LISA Pathfinder spacecraft at Airbus, UK

Astronomy and Physics Directorate

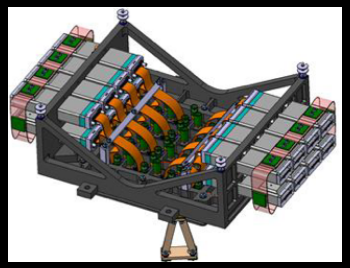
Instruments and Missions in Development



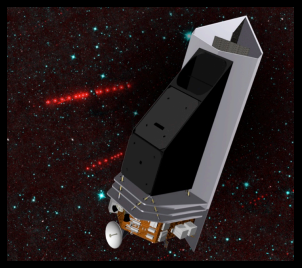
Mid-IR Instrument (MIRI) and Cooler for JWST (Delivered)



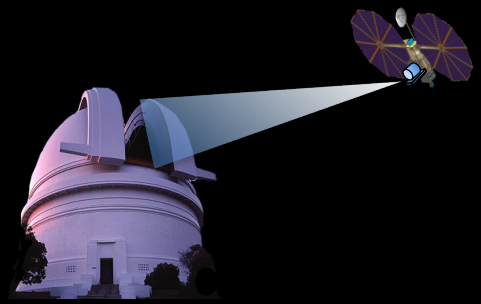
Deep Space Atomic Clock (Delivered)



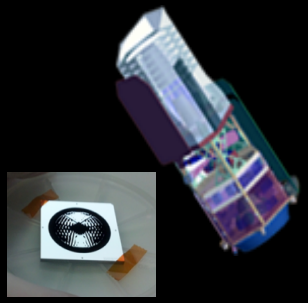
Sensor System for the Near-IR Photometer Instrument for Euclid



NEOCAM (Phase A)

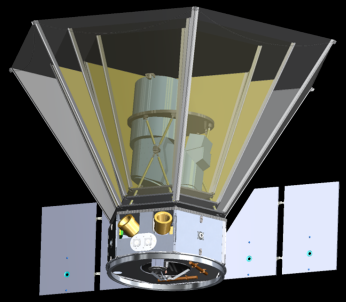


Deep Space Optical Communications

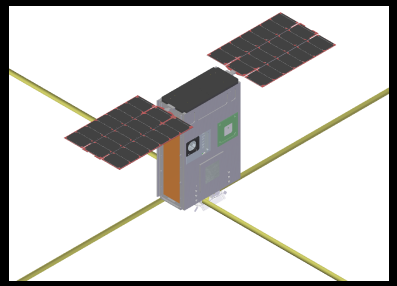


WFIRST Coronagraph (CGI) (Phase B)

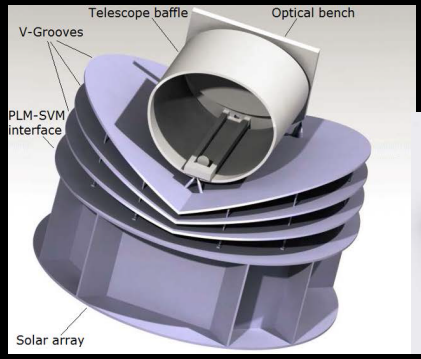
Future Mid-Explorer Mission Candidates in Step-2 (Phase A)



SPHEREx: Infrared all sky spectroscopic survey.

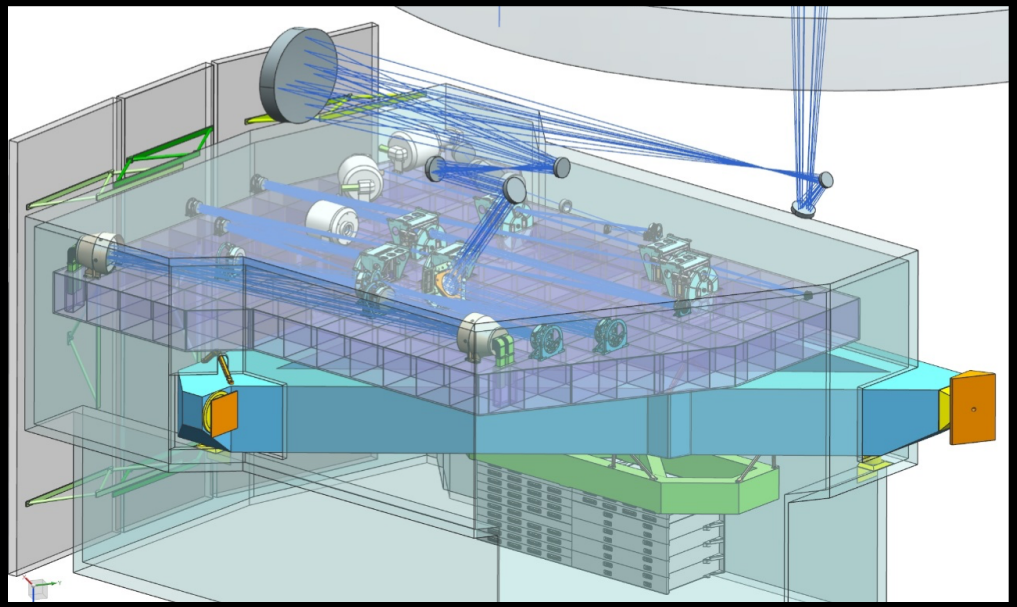


SunRISE (MoO): 6 s/c cubesat synthetic aperture radio telescope studying how solar energetic particles are accelerated and released into interplanetary space.



CASE (MoO w/ESA): Contribution of detectors to ESA's ARIEL Mission for transit spectroscopy of exoplanet atmospheres

WFIRST Coronagraph Instrument (CGI)

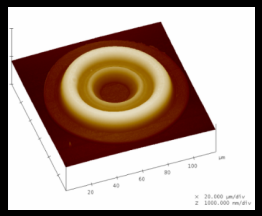


<u>Critical Technology demonstration for the Future exo-earth missions:</u>

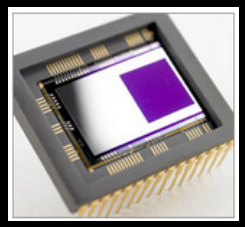
- First in-space demonstration of active wavefront sensing and control to 10's of pms using deformable mirrors (DM).
- First in-space use of ultra-low noise photon counting detectors to image exoplanets.

<u>WFIRST Coronagraph Instrument (CGI) capabilities:</u>

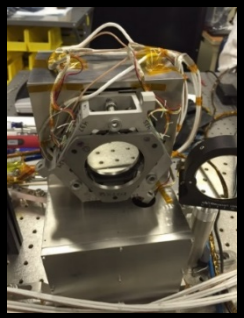
- A quantum leap (x 10^3) compared to space (HST/ JWST) and ground state-of-the art (GPI/ SPHERE)
- Able to image exoplanets that are 1 billion times fainter than the host stars
- Available to support proposed GO programs.



HLC mask image with an atomic force microscope



E2V EMCCD used in photon counting mode

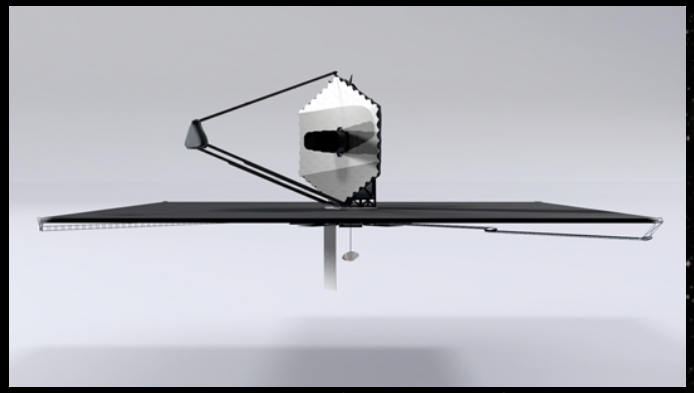


Fast-steering mirror (FSM)

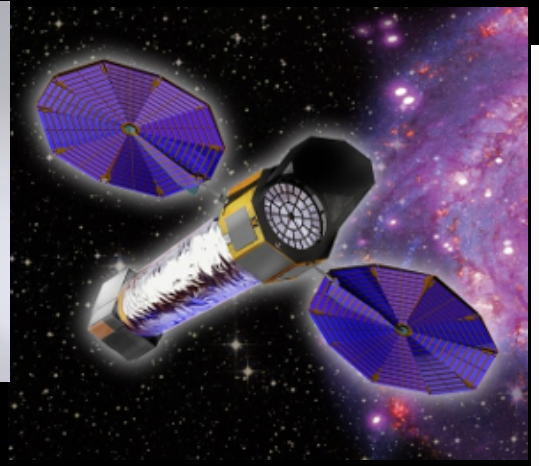
Xinetics 48 x 48 DM used in JPL's HCIT

Astro2020 Large Mission Studies

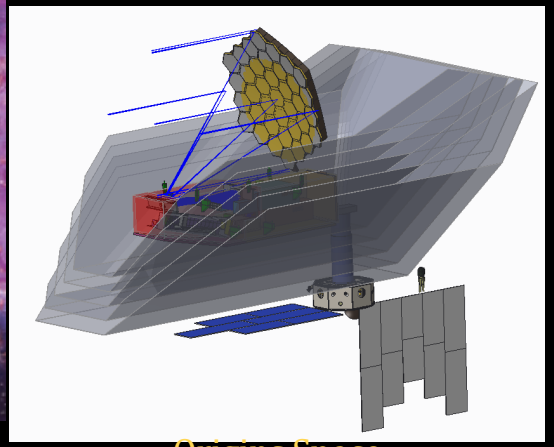
HABEX:
4 m telescope
Starshade + Coronagraph
for habitable exoplanets &
general science



LUVOIR: 9-15 m general observatory also with exoplanet direct imaging with coronagraph



Lynx: high energy X-ray observatory

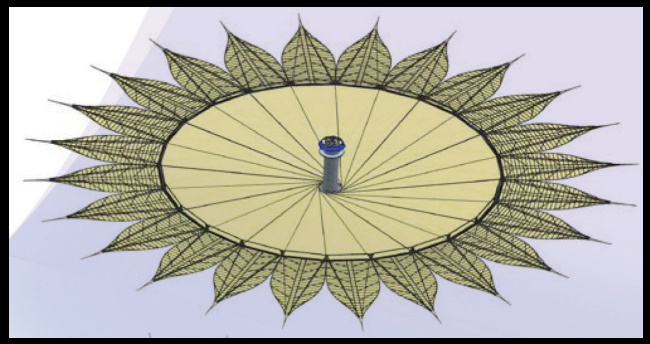


Origins Space Telescope: 9 m telescope @ 4K temperature

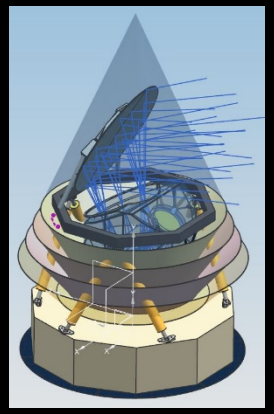
Astrophysics Probe Concepts May Create a New Opportunity

5 of 10 studies are working with JPL

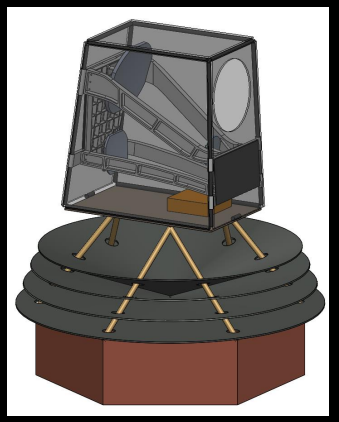
Starshade Rendezvous Probe could be the first in a new mission line



Starshade Rendezvous
PI: Sara Seager & Jeremy Kasdin

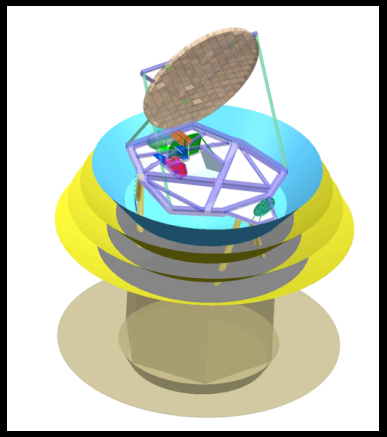


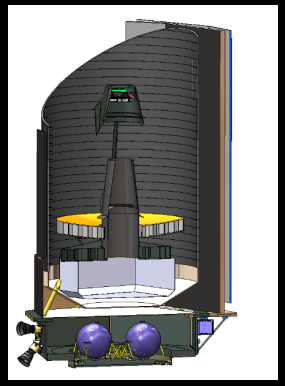
PICO – Inflation Probe
PI: Shaul Hanany



Cosmic Dawn Intensity Mapper
PI: Asantha Cooray

Galaxy Evolution Probe
PI: Jason Glenn





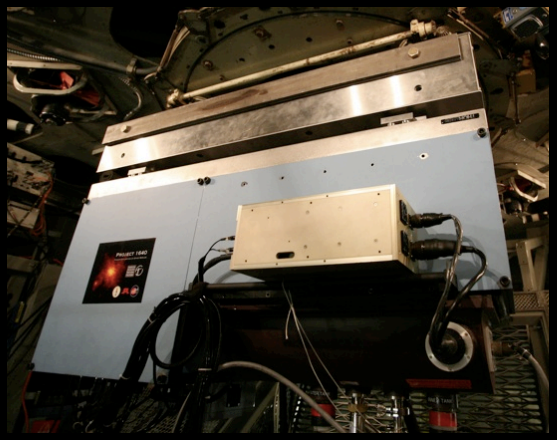
Earthfinder PRV
PI: Peter Plavchan

Ground Based Activities- Incubators for Flight Instruments

Vector Vortex Coronagraph & Keck Cosmic Wave Imager (KCWI)

Subaru Telescope Prime Focus Spectrograph

Thirty Meter Telescope

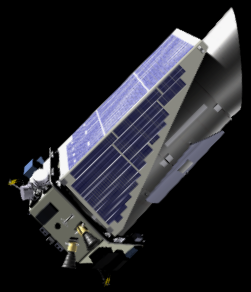


P1640 Calibrator & Coronagraph at Palomar

NASA Exoplanet Exploration Program

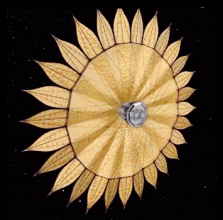
Space Missions and Mission Studies

Kepler & K2

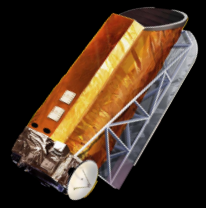


Probe-Scale Studies

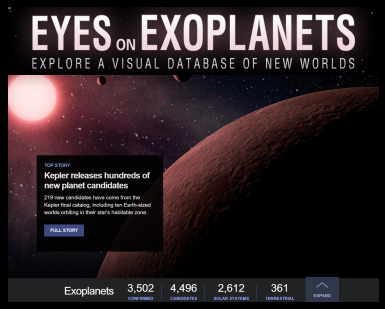
Starshade



Coronagraph



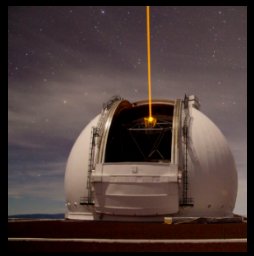
Communications



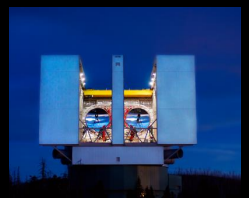
Supporting Research & Technology

Key Sustaining Research

NN-EXPLORE



Keck Single Aperture Imaging & RV



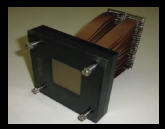
Large Binocular Telescope Interferometer

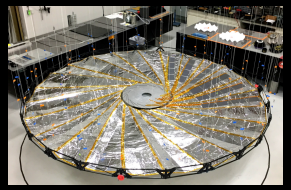
Technology Development

Occulting Masks

High-Contrast Imaging

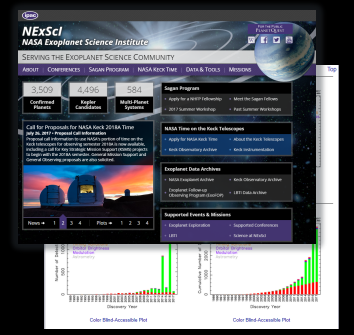
Deformable Mirrors





Deployable Starshades

NASA Exoplanet Science Institute



Archives, Tools, Sagan Fellowships, Professional Engagement

Jet Propulsion Laboratory
California Institute of Technology